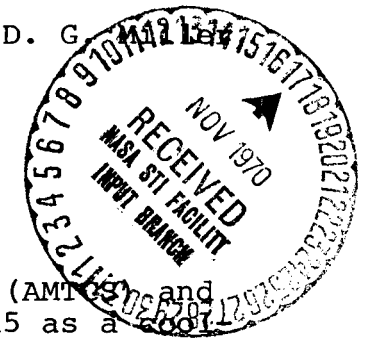
BELLCOMM. INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B70 10048

SUBJECT: Coolanol-15 - Case 620

DATE: October 21, 1970

FROM: D. G. Miller



MEMORANDUM FOR FILE

The Airlock Module Thermal Control System (AMTCS) and the Workshop (WS) refrigerant system use Coolanol-15 as a coolant inside the Skylab. The fire hazard of Coolanol-15 was reviewed at a recent meeting of the OMSF Management Council.

Coolanol-15 was the Gemini Environmental Control System coolant, identified as MSC 198, a silicate ester product of the Monsanto Chemical Co. The flash fire temperature of Coolanol-15 at sea level is 170°F-185°F. However, it has been reported that, for the oxygen-rich atmosphere and zero-g environment of Skylab, it is expected lower temperatures on the order of 160°F would provide a potential flash fire condition.(1)

In order to eliminate this potential fire hazard from the Skylab interior, one of the following changes is necessary:

1. An entirely new AMTCS & WS refrigerant system.
2. Isolation or containment of Coolanol-15 outside the Skylab.
3. Substitution of another coolant.

New System

An entirely new system is desirable for optimizing a cooling system with a nonflammable coolant; but certainly this change is unattractive, from cost and schedule considerations.

Isolation or Containment of Coolanol-15

This could be accomplished by replumbing the systems containing Coolanol-15 in a manner that only those components outside the Skylab would contain Coolanol-15. This would remove the fire hazard from inside the Skylab and would be desirable in retaining a significant portion of the qualified hardware, e.g. radiators and certain electronic cold plates. The internal cooling components, such as the cabin and condensing heat exchangers, could be cooled by a water system interfacing

outside the Skylab in a Coolanol-15/water heat exchanger. This is similar to the current water systems used for the AM Control & Display panel and for suit cooling. The major internal and external AMTCS components are listed in Table I. A schematic of the present coolant loop is shown in Figure 1 with the addition of a Coolanol-15/water heat exchanger and water pump module. The internal components are circled.

A system very similar to this was proposed by McDonnel Douglas Astronautics Eastern Division (MDAC-ED); however, radiant panels were used in place of the cabin heat exchangers.(2)

Substitution of Coolant

Simply substituting another coolant for Coolanol-15 would be attractive, if a coolant were found with the following properties: acceptable flammability and toxicity hazard levels, compatible heat transfer and flow properties, and compatible materials properties. Compatibility is essential to minimize redesign and requalification of the thermal control system hardware listed in Table I.

The current Apollo and Skylab program coolants and their physical properties are listed in Table II.(3) Data show that glycol-water, although flammable under certain conditions, is significantly less flammable than Coolanol-15.(4) A list of known potential coolants which may be considered for substitution of Coolanol-15 is given in Table III.

D. G. Miller

1022-DGM-tla

Attachments

REFERENCES

1. "Skylab Program Payload Integration Engineering Data and Analysis Caution and Warning System Integration Problem Resolution: Coolanol-15 Hazards" Report ED-2002-1071 April 21, 1970 Martin Marietta Corporation, Denver Division.

2. "Thermodynamics Technical Note No.24 Cluster Temperature Control System Study" MAC-ED Sept. 1969.

3. Waldo, J. E., Bellcomm Seminar on Thermal Control, May 5, 1970.

4. Huson G. R., "Flammability of Aqueous Ethylene Glycol - Case 330, Bellcomm Memorandum for File, May 22, 1967.

TABLE I

MAJOR AMTCS COMPONENTS
CONTAINING COOLANOL-15

INTERNAL (WITHIN PRESSURIZED VOLUME)

- CONDENSING HEAT EXCHANGERS
- CABIN AFT HEAT EXCHANGERS
- CABIN STS HEAT EXCHANGERS
- TAPE RECORDER COLD PLATE

EXTERNAL (OUTSIDE PRESSURIZED VOLUME)

- RADIATOR
- THERMAL CAPACITOR
- EVA, IVA SUIT HEAT EXCHANGERS
- COOLANT THERMAL CONTROL VALVE
- ATM WATER/COOLANOL-15 HEAT EXCHANGER
- O_2 HEAT EXCHANGER
- BATTERY MODULE COLD PLATE
- 5 ELECTRONIC MODULE COLD PLATES
- COOLANT RESERVOIRS
- PUMP MODULE
- SELECTOR VALVE
- GROUND COOLING HEAT EXCHANGER

TABLE II *

FLUIDS FOR COOLANT LOOPS

DESIRABLE PROPERTIES

LOW FREEZING POINT
HIGH SPECIFIC HEAT
HIGH THERMAL CONDUCTIVITY
LOW VISCOSITY
MODERATE VAPOR PRESSURE
LOW HAZARD - TOXICITY, FLAMMABILITY

	BOILING POINT AT 1 ATM °F	FREEZING POINT °F	DENSITY LB/FT^3	VAPOR PRESSURE PSIA @ 100°F	SPECIFIC HEAT BTU/LB°F	THERMAL CONDUCTIVITY BTU/HR FT°F	VISCOSITY LB/FT HR
GLYCOL WATER 62.5/37.5 APOLLO CSM APOLLO LM	464	-80	67	0.7	0.76	.22	6.8
COOLANT 15 GEMINI SKYLAB AM	460	<-120	55	<1.0	0.45	.06	3.6
METHANOL-WATER 80/20 SKYLAB ATM	-	-154	53	4.0	0.72	.15	2.7

*Reference 3

TABLE III

POTENTIAL COOLANT SUBSTITUTES FOR COOLANOL-15

COOLANT	ADVANTAGES	DISADVANTAGES
FC-75	NON-CORROSIVE AND NON-TOXIC	POSSIBLE HIGH PUMPING POWER
COOLANOL-35*		
COOLANOL-45*		
FREON E-2	NON-CORROSIVE	POOR THERMAL CHARACTERISTICS, HIGH PUMPING POWER
FREON E-3	NON-CORROSIVE	SAME AS E-2
GLYCOL/WATER (62.5/37.5)	GOOD THERMAL PROPERTIES	FLAMMABLE UNDER CERTAIN CONDITIONS, HIGH FREEZING POINT, CORROSIVE

* REFERENCE 1 RECOMMENDED FC-75, COOLANOL-35, AND COOLANOL-45 AS SUBSTITUTES FOR COOLANOL-15. ADVANTAGES AND DISADVANTAGES OF COOLANOL-35 AND -45 WERE NOT GIVEN.

airlock

COOLANT SYSTEM

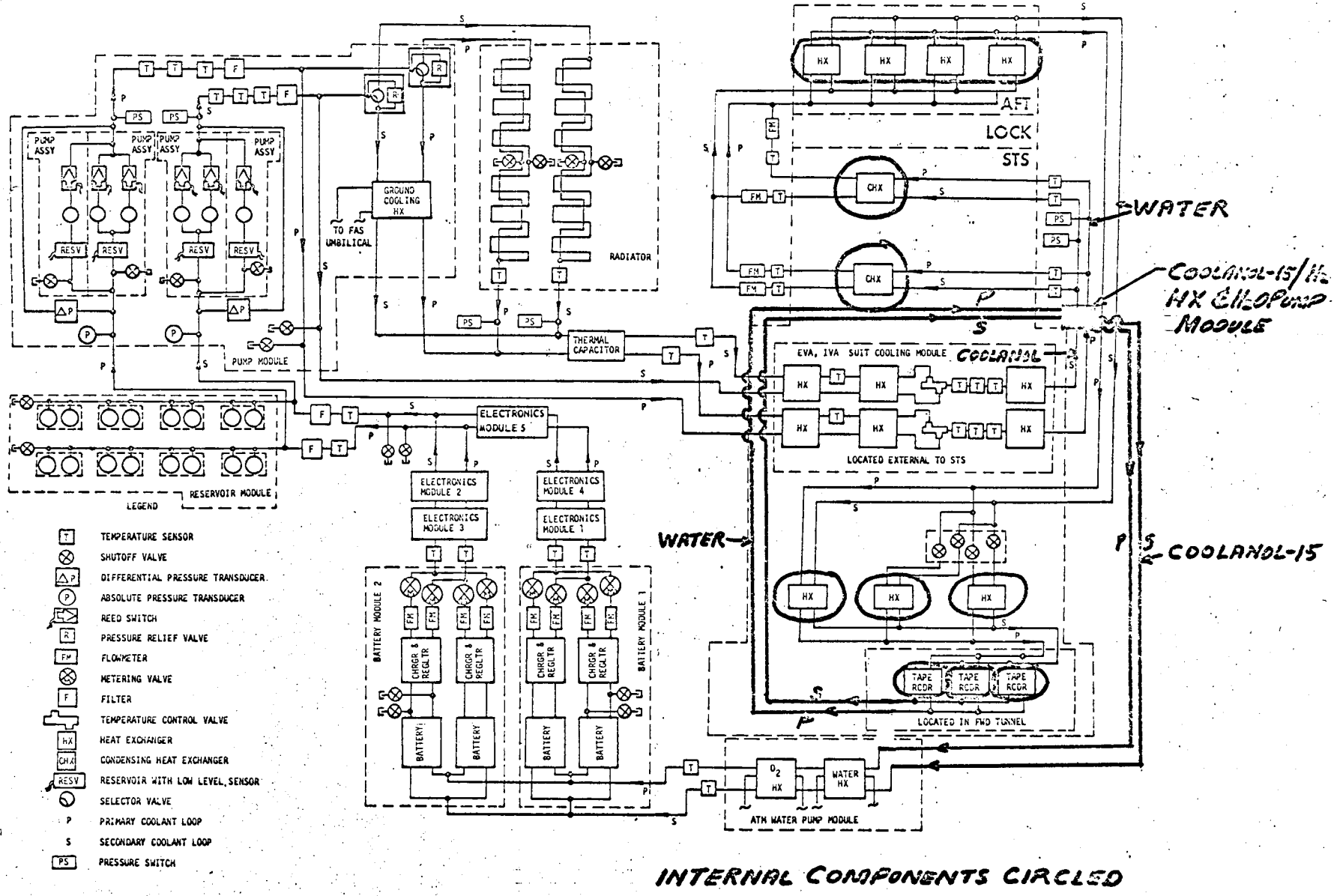


FIGURE 1

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Subject: Coolanol-15 - Case 620 From: D. G. Miller

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